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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Bruno GHYSELEN et al.

Confirmation No.: 2668

Patent No.: 7,033,905 B2

Application No.: 10/726,039

Patent Date: April 25, 2006

Filing Date: December 1, 2003

For: RECYCLING OF A WAFER COMPRISING A BUFFER LAYER AFTER HAVING SEPARATED A THIN LAYER THEREFROM BY MECHANICAL MEANS

Attorney Docket No.: 4717-8600

REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. § 1.322

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Patentees hereby respectfully request the issuance of a Certificate of Correction in connection with the above-identified patent. The corrections are listed on the attached Form PTO-1050. The corrections requested are as follows:

Title Page:

Item (75) Inventors, after "**Yves-Mathieu**" change "**Vaillant**" to -- **Le Vaillant** --. The inventor's name will then correctly read as "**Yves-Mathieu Le Vaillant**".

Item (63) **Related U.S. Application Data**, after "Continuation of application no." change "PCT/FR03/02578" to -- PCT/IB03/004029 --.

Support for the above changes appear in the Amendment After Allowance and Supplemental Declaration filed December 16, 2005.

Column 18:

Line 11 (claim 15, line 3), after "ternary," change "quatemary" to -- quaternary --. Support for this change appears in original application claim 13.

The requested corrections are for errors that appear to have been made by the Office. Therefore, no fee is believed to be due for this request. Should any fees be required, however, please charge such fees to Winston & Strawn LLP Deposit Account No. 50-1814. Please issue a Certificate of Correction in due course.

Respectfully submitted,

5-2-06

Date

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212-294-3311

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.: 7,033,905 B2
DATED: April 25, 2006
INVENTORS: Ghyselen et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title Page,
Item (75) Inventors, after "**Yves-Mathieu**" change "**Vaillant**" to -- **Le Vaillant** --.
Item (63) **Related U.S. Application Data**, after "Continuation of application no." change "PCT/FR03/02578" to -- PCT/IB03/004029 --.

Column 18,
Line 11 (claim 15, line 3), after "ternary," change "quatemary" to -- quaternary --.

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(12) **United States Patent**
Ghyselen et al.

(10) **Patent No.: US 7,033,905 B2**
(45) **Date of Patent: Apr. 25, 2006**

(54) **RECYCLING OF A WAFER COMPRISING A BUFFER LAYER AFTER HAVING SEPARATED A THIN LAYER THEREFROM BY MECHANICAL MEANS**

(75) Inventors: **Bruno Ghyselen**, Seyssinet-Pariset (FR); **Cécile Aulnette**, Grenoble (FR); **Bénédite Osternaud**, Saint Egreve (FR); **Yves-Mathieu Vaillant**, Crolles (FR); **Takeshi Akatsu**, Saint Nazaire les Eymes (FR)

Le Vaillant

(73) Assignee: **S.O.I.Tec Silicon on Insulator Technologies S.A.**, Bernin (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/726,039**

(22) Filed: **Dec. 1, 2003**

(65) **Prior Publication Data**

US 2004/0110378 A1 Jun. 10, 2004

PCT/IB03/004029 **Related U.S. Application Data**

(63) Continuation of application No. PCT/FR03/02578, filed on Aug. 26, 2003.

(60) Provisional application No. 60/431,930, filed on Dec. 9, 2002.

(30) **Foreign Application Priority Data**

Aug. 26, 2002 (FR) 02 10588

(51) **Int. Cl.**
H01L 21/76 (2006.01)

(52) **U.S. Cl.** **438/406**; 438/455; 438/458; 438/459

(58) **Field of Classification Search** 438/455–459, 438/406–409, 507
See application file for complete search history.

(56) **References Cited**

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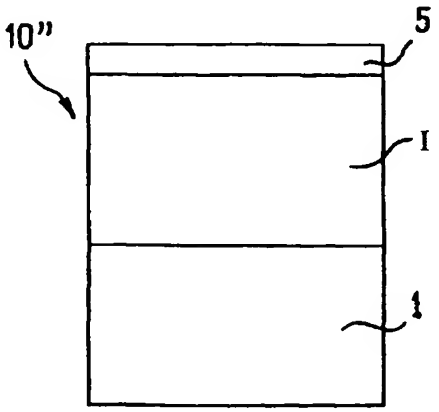
(74) *Attorney, Agent, or Firm*—Winston & Strawn LLP

(57) **ABSTRACT**

A method of recycling a donor wafer after detaching at least one useful layer is provided, the donor wafer comprising successively a substrate, a buffer structure and, before detachment, a useful layer. The method comprises employing mechanical means to remove part of the donor wafer on the side where the detachment took place, such that, after removal of substance, there remains at least part of the buffer structure capable of being reused as at least part of a buffer structure during a subsequent detachment of a useful layer. The present document also relates to methods of detaching a thin layer from a donor wafer which can be recycled according to the invention, as well as donor wafers which can be recycled in accordance with the invention.

33 Claims, 3 Drawing Sheets



invention. Thus, it is intended that the present invention include all such modifications and variations within the scope of the appended claims and their equivalents.

What is claimed is:

1. A method of recycling a donor wafer after detachment of a useful layer of a semiconductor material therefrom, wherein the donor wafer, after detachment of the useful layer, includes a substrate, a buffer structure on the substrate, and a remaining portion of the useful layer, the buffer structure including a buffer layer that has a first side with first crystalline properties, for association with the substrate, and a second side with second crystalline properties that are different from the first crystalline properties, for association with the useful layer, and a portion transitioning between the first and second properties, which method comprises mechanically removing at least part of the remaining portion of the useful layer while preserving the buffer layer in order to provide a donor wafer surface that is suitable for use in a subsequent detachment of a new useful layer.

2. The method of claim 1, wherein the mechanically removing comprises polishing.

3. The method of claim 2, wherein the polishing is abrasive polishing or chemical-mechanical planarization.

4. The method of claim 2, which further comprises conducting a surface smoothing treatment before polishing, after polishing, or both before and after polishing to enable providing the new useful layer thereon.

5. The method of claim 4, wherein the surface smoothing treatment includes a heat treatment.

6. The method of claim 1, wherein, before detachment, the buffer structure includes an additional layer associated with the second side.

7. The method of claim 6, wherein the mechanically removing includes removing all of the remaining portion of the useful layer and part of the additional layer or all of the additional layer and part of the buffer layer.

8. The method of claim 6, wherein the additional layer has a thickness that is sufficient to contain crystalline defects therein to improve the crystalline qualities of the useful layer on the buffer structure.

9. The method of claim 6, wherein at least part of the additional layer is preserved after the mechanical removing.

10. The method of claim 1, which further comprises providing at least one new layer on the donor wafer after mechanically removing at least part of the remaining portion of the useful layer so as to form a new useful layer above the existing buffer structure.

11. The method of claim 10, which further comprises, before detachment, providing the donor wafer with an overlayer which includes the useful layer to be detached, and wherein the mechanically removing removes any portion of the overlayer that remains after detachment.

12. The method of claim 11, wherein the overlayer includes

(a) a material selected from the group consisting of SiGe and strained Si;

(b) a material selected from the group consisting of AsGa and Ge; or

(c) InP or another alloy of Group III-V elements.

13. The method of claim 10, which further comprises providing at least two new layers on the donor wafer after mechanically removing at least part of the remaining portion of the useful layer so as to form an interlayer between the buffer structure and the new useful layer, with the interlayer optionally being provided by layer growth.

14. The method of claim 13, wherein the interlayer includes

(a) a material selected from the group consisting of SiGe and strained Si;

(b) a material selected from the group consisting of AsGa and/or Ge;

(c) an alloy of Group III-V elements; or

(d) a material selected from the group consisting of InP and a Group III-V material having a lattice parameter substantially identical to that of InP.

15. The method of claim 13, wherein the buffer structure has a composition that includes an atomic alloy of binary, ternary, quatemary or of higher degree, selected from the group consisting of Group IV-IV elements; Group III-V elements, and Group II-VI elements.

quaternary

16. The method of claim 1, wherein

(a) the substrate includes Si and the buffer structure includes a SiGe buffer layer having a Ge concentration that increases with thickness and a relaxed SiGe layer on the buffer layer;

(b) the substrate includes AsGa and the buffer structure comprises a buffer layer comprising an atomic alloy of Group III-V elements of ternary or higher degree that is selected from possible (Al,Ga,In)—(N,P,As) combinations with at least two additional elements selected from the group consisting of Group III and Group V elements, wherein the two additional elements have a concentration that changes gradually with thickness of the buffer layer;

(c) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 50%; or

(d) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 5%.

17. The method of claim 1, which further comprises:

providing a zone of weakness beneath the donor wafer surface;

bonding the donor wafer surface to a surface of a receiving substrate; and

detaching a useful layer from the donor wafer along the zone of weakness.

18. The method of claim 17, wherein the method further comprises, before the bonding step, forming a bonding layer on the donor wafer surface.

19. The method of claim 17, wherein the zone of weakness is formed by implantation of atomic species through the useful layer.

20. The method of claim 1, wherein the useful layer that is detached includes part of the buffer structure.

21. The method of claim 1, wherein the donor wafer includes, before detachment, an overlayer located on the buffer structure, and the useful layer that is detached includes at least part of the overlayer.

22. The method of claim 1, wherein the first crystalline properties comprise a first lattice parameter, and the second crystalline properties comprise a second lattice parameter to enable the useful layer to be associated with the substrate via the buffer layer.

23. The method of claim 22, wherein the substrate has a lattice parameter that is different from the lattice parameter of the useful layer.

24. The method of claim 1, wherein the remaining portion of the useful layer is insufficient to transfer a new useful layer therefrom without adding material thereto.

25. The method of claim 1, wherein the buffer structure is reformed before a new useful layer is added thereon.

26. A method of recycling a donor wafer after detachment of a portion of an overlayer that includes a useful layer of a